POTASH IN AGRICULTURE

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Potash is one of the three "essential elements of fertility"—nitrogen, phosphoric acid, and potash. These elements have received this appellation not because they are any more essential to the growth of crops than the other nine or ten elements entering into the composition of plant tissues, but because they are the three which must be constantly returned to the soil if its productiveness is to be maintained under our ordinary systems of farming, which, as we well know, entail the removal and sale of at least a portion of our crops.

Of the three, potash is more widely distributed and less frequently deficient in soils than nitrogen and phosphoric acid and may be considered the least important from the standpoint of the necessity of application. Clay loams as a rule are well supplied with potash and seldom respond profitably to an application of a special potassic fertilizer. Indeed upon heavy clays such an application may depress the yield by bringing about an unfavourable condition of tilth. It is more particularly sandy and gravelly loams, calcareous soils and soils rich in vegetable matter, as mucks and peaty loams, which are poor in potash and upon which this element may be expected to give a profitable return.

Again, it is not all crops that call for special potassic manuring. On our staple cereal crops, wheat and oats, potash seldom gives a remunerative return, save on the lightest and driest soils. Barley for malting purposes is to some degree an exception among the cereals, frequently responding profitably to potassic manures and particularly so on sandy soils.

If potassium is one of the essential elements for growth, as we have stated, it must perform certain vital functions in plant nutrition. The most important of these, it would appear, is related to and indispensable for the production of the carbohydrates—starch, sugar, and cellulose—within the plants. Hence it is that crops rich in these constituents—mangels, sugar beets, potatoes, sunflowers, corn, etc.—are those which are specially benefited by potassic manures. Fruits, large and small, and the leguminous plants—clover, peas, etc.—must be added to the list of those responding to potash. These are the crops, then, on sandy, gravelly loams, for which potash should be reserved, whether it be contained in a purchased fertilizer or one of the home resources, as wood ashes, seaweed, etc.

COMMERCIAL SOURCES OF POTASH

The greater part of the potash used in Canada for fertilizing purposes is imported in the form of muriate of potash, sulphate of potash, sylvanite and kainite from the Alsace-Lorraine deposits of France and the Stassfurt mines of Germany. During the year of 1924, there were brought in, approximately, 10,000 tons of these salts, of which about 95 per cent was in the form of muriate.

Muriate of potash contains from 48 to 50 per cent of potash (K_2O) and is largely used in the manufacture of ready-mixed fertilizers, and by farmers and farmers' organizations in their home mixing of fertilizer materials. It is the most popular source of potash and is adapted for use on nearly all crops requiring a potassic fertilizer.

Sulphate of potash contains approximately 50 per cent of potash (K_2O) and is preferred to the muriate for tobacco and sometimes for such special crops as potatoes, sugar beets, etc.

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Sylvanite (20 to 30 per cent K_2O) and Kainite (12 to 14 per cent K_2O) are low-grade potash salts and their use has not become general in Canada.

"Trona" potash, manufactured in California, U.S.A., is similar in composition to the muriate of potash imported from Europe. It has been used to a limited extent in Canada in the preparation of mixed fertilizers.

MANURE AS A SOURCE OF POTASH

Farm manures are not usually thought of as a source of potash, much to our national loss. It may be safely said that thousands of tons of potash from this source are annually wasted in Canada. With certain minor exceptions, as in the wool of sheep and the milk of dairy cows, practically all the potash in the feeds and fodders consumed by our farm stock is excreted by the kidneys. More than 90 per cent of the total potash excreted by the animals is to be found in the urine, and this in addition to the fact that one-half or more of the total nitrogen excreted is also present in the liquid excreta. It thus comes about that weight for weight, urine has a greater manurial value than the solid excrement, and this not only by reason of its larger percentages of potash and nitrogen, but because these constituents are in a soluble condition and practically at once available for the nutrition of crops. To support these statements we append the following data, giving the average composition of the solid and liquid excreta of our farm stock.

COMPOSITION OF URINE AND SOLID EXCRETA

Animal	Excreta	Water	Nitrogen	Phosphoric Acid	Potash
		p.c.	p.c.	p.c.	p.c.
Horse	Solid	75·0	0·56	0·35	0·1
	Liquid	90·0	1·52	trace	0·92
Cow	Solid	86·0	0·44	0·12	0·04
	Liquid	91·5	1·05	trace	1·36
Sheep	Solid	57·6	0·72	0·44	0·30
	Liquid	86·5	1·31	0·01	2·0
Pig	Solid	76·0	0·48	0·58	0·36
	Liquid	97·6	0·50	0·14	0·70

It has already been stated that practically all the potash in the foods is excreted by the animal. To illustrate this fact the following results of an experiment conducted at the Rothamsted Experimental Station may be given.

POTASH RETAINED AND EXCRETED

——	In 100 lb. Oil cake	Fattening Steers			Milch Cows		
	Lb.	In Meat	In Urine	In Feces	In Meat	In Urine	In Feces
Potash	1·4	0·02	1·10	0·28	0.14	1.05	0·21

The evidence is therefore conclusive as to the greater richness of liquid manure in potash. To allow it to be wasted as it is on too many farms to-day is little short of a crime against the land. Its value as a nitrogenous fertilizer could be emphasized even more strongly than as a source of potash, but the chief object in this bulletin is to call attention to it as the latter. By conserving this liquid manure and returning it to the land practically all the potash taken out of the soil by the growth of our crops could be put back for future use. It

will not be found advantageous to run off this liquid manure into cisterns for subsequent application as such to the land as is done in many European countries, owing to our rigorous winter and the high price of labour, but a sufficient quantity of absorbent bedding material to hold it with the solid excrement must be used. Straw, preferably cut short, and air-dried peat and muck are excellent absorbents and they subsequently give up their plant food to swell the amount contained in the excreta, besides giving bulk which will facilitate the more uniform distribution of the resulting manure on the land.

WOOD ASHES AS A POTASSIC FERTILIZER

The ashes of wood have long been recognized as a fertilizer of very considerable value, indeed their use in agriculture is historic. In all countries, including Canada, practising agriculture, they have been highly prized, especially for clover, grapes and fruit trees and leafy crops generally, on sandy and light loams and it was only with the advent of the high grade potash salts that their use fell off, though of course, their production in decreasing quantities of late years, owing to the disappearance of our forests, has been an important factor in making it more and more difficult for the farmer in the older-settled districts to obtain them.

They are essentially a potassic fertilizer, ashes of good quality, that is, dry, unmixed with sand, etc., and unleached, containing between 4 per cent and 6½ per cent potash—the average potash content being about 5½ per cent. This potash is in a soluble form and hence immediately available for crop use; moreover, it exists in these ashes in a condition (the carbonate) much more favourable for the nutrition of plants than in more commonly used compounds and should be worth at least 1 cent per pound more than in the latter. There is in fact no better potassic fertilizer.

In addition to their potash wood ashes contain some 2 per cent phosphoric acid and from 20 to 30 per cent carbonate of lime, enhancing their fertilizing value and making them, in a sense, an all-round fertilizer for supplying the mineral elements required by crops. And, further, they correct acidity, a condition detrimental to the thrift of most farm crops. Muriate and sulphate of potash are of no value for neutralizing acidity.

Naturally, genuine wood ashes are somewhat variable in composition, depending partly on the nature of the wood producing them and partly on the care with which they have been collected and stored. Wilful adulteration of a gross character has been occasionally detected in commercial samples, addition of sand and other inert matter and leaching being the most common forms of adulteration.

There is a general belief that ashes from hard woods, as a class, are richer in potash than those from soft woods but our analyses scarcely confirm this impression. As might be expected, woods differ very considerably in their potash content and the ashes of twigs and boughs are much richer than those of trunk woods. Pine and other soft woods as a rule contain less ash than the hard woods and are much lighter in character and it is this latter quality or property we think that has given rise to the common belief referred to. According to our results we cannot find that *weight for weight*, the ashes of soft wood are much, if any, poorer than those from hard woods.

Our advice must therefore be to conserve more carefully this home source of potash, not merely collecting the ashes from the house stoves but burning such brush piles, old roots, etc., as may result from the clearing of land, pruning of orchards, etc., and saving the resulting ashes. Storage in a shed or receptacle protected from the weather is essential to prevent deterioration.

From 25 to 50 bushels of wood ashes per acre will furnish from 60 to 120 pounds of potash, the latter an ample dressing for even very light soils. They

are not needed on heavy clay loams, indeed their use on such may destroy good tilth and do more harm than good. Their application is best deferred till spring, broadcasting, preferably on a quiet damp day, on the ploughed land and incorporating with a thorough harrowing.

For clover, corn and mangels, they will be found very valuable. Especially are they beneficial for orchards and for grapes on sandy loams. For turnips, mixed with one-third to one-half their weight of bone meal, they have similarly proved advantageous. But indeed there are few crops on light and gravelly soils, as also on vegetable loams inclined to be sour, for which wood ashes cannot be employed with profit.

SEAWEED AS A POTASSIC FERTILIZER

The use of seaweed as a fertilizer dates back to historic times and its value for the upkeep of soil fertility has been generally and practically recognized in both the old world and the new by farmers residing not too far distant from the coast line. Seaweed occurs on both our Atlantic and Pacific coasts (more abundantly probably on the latter) and may be collected in large amounts at little expense on many sea beaches, where it is thrown up by storms at times in prodigious quantities. It can also be collected in boats from rocks and floating masses not far from the shore. There are many varieties, some are quite small, others attain large proportions, but all are valuable, though naturally differing somewhat in composition.

Seaweed is essentially a potassic fertilizer, being specially rich in potash, but it also contains notable amounts of nitrogen and other elements of plant food, so that it might be termed a complete manure.

Analyses of many Canadian seaweeds, more especially from the Atlantic seaboard, have been made in the Experimental Farm laboratories at Ottawa, and we append in tabular form certain of the data as illustrative of their general composition.

ANALYSES OF SEAWEEDS COLLECTED ON THE ATLANTIC SEABOARD

—	Fucus furcatus	Fucus vesiculosus	Ascophyllum nodosum	Porphyra laciniata	Laminaria longicruris
Water	63·49	88·29	75·14	79·42	88·30
Organic matter	27·93	7·61	19·30	15·15	7·15
Ash or mineral matter	8·58	4·10	5·56	5·43	4·55
	100·00	100·00	100·00	100·00	100·00
Nitrogen	0·468	0·182	0·273	0·928	0·251
Phosphoric acid	0·108	0·037	0·070	0·068	0·134
Potash	2·025	0·615	0·619	0·619	1·546

Fresh seaweed is undoubtedly a watery manure, and it is this fact, no doubt—the cartage being a more or less expensive feature—that limits its use to those living more or less close to the shore. A part of this useless water may be got rid of by piling the seaweed on the beach for a few days before hauling to the farm. But notwithstanding its large percentage of water, seaweed compares very favourably, weight for weight, with barnyard manure and it has this additional value that it brings to the farm no weed seeds or insects or fungus pests.

The essentially potassic character of seaweeds is well brought out by the analyses given, but it will also be noted that they are especially high in nitrogen. The differences in composition between the varieties may in part be accounted for by the stage of growth or maturity at the time of collection, and in this connection it is interesting to note that for several varieties collections made during the winter have shown a higher potash content than samples taken in summer.

The manurial value of seaweed is greatly enhanced by its ready decomposition in the soil; it quickly decays, liberating its constituents in forms available for plant nutrition. It is quite unnecessary to compost it, though little loss would ensue if composting with muck or other vegetable matter which would absorb and hold the decomposition products is resorted to, provided the heap is not exposed to heavy leaching rains. The weathering of seaweed alone is a wasteful process. On the whole, the best plan is to apply the seaweed direct to the soil, with which it readily becomes incorporated. It is essentially of the nature of a quickly acting, forcing manure.

Seaweed can be employed for all classes of crops, though it will be found most useful for roots, vegetables, and those plants with an abundance of foliage, since it is essentially a nitrogenous and potassic manure. It has given excellent results as a top dressing for grass lands, encouraging the growth of clover more particularly. Its composition suggests that if a more complete fertilizer is desired it should be supplemented by superphosphate, basic slag or bone meal. Seaweed gives its best returns on moderately light loams that are warm and moist and its poorest on wet, ill-drained, heavy clays.

DRIED, GROUND SEAWEED

It would seem possible to dry and grind the seaweed at some point near its collection and thus prepare from this naturally-occurring fertilizer a material convenient for application to the land and sufficiently rich in plant food to allow of inland transportation. The writer analyzed such a material some years ago. It had been prepared in Nova Scotia from rockweed *(Fucus furcatus)*, a gentle heat being used in the drying. It was a coarse, dark green powder, one which might readily be broadcast or applied by the fertilizer attachment of the seed drill. The analysis furnished the following data:—

Water	9.48
Organic matter	72.61
Ash or mineral matter	17.91
	100.00
Nitrogen	1.32
Phosphoric acid	0.29
Potash	2.26

These data are in fair accord with those obtained from the analysis of fresh rockweed, calculated to the same moisture content as the sample examined and we may conclude, therefore, that there had been no appreciable losses in the plant food constituents during the drying of the weed. We do not think that the drying brought about any marked impairment in availability.

Inquiries as to the possibility of preparing this seaweed powder on a commercial scale elicit the information that attempts have been frequently made in Europe to prepare an easily handled, concentrated fertilizer from seaweed, but that so far the mechanical and other difficulties in drying and grinding, largely consequent upon the mucilaginous character of the seaweed, have been such as to prevent the manufacture being carried on profitably.

LIBERATORS OF POTASH

There is no substitute for potash in agriculture; it cannot be replaced in the plant's economy by soda or any other compound. But there are certain substances that act as excitants or liberators of the locked-up, inert stores of potash in the soil and thus may be considered as indirect potash fertilizers. Two of these, gypsum and nitrate of soda, may be briefly discussed.

Gypsum, commonly known in the ground form as land plaster, is a naturally-occurring sulphate of lime. Although supplying lime it is of no value for the correction of acidity (sourness) of soils, for which purpose lime or ground limestone must be employed. But the furnishing of lime does not constitute its chief manurial value. It has the property of acting on the insoluble potassic compounds of the soil, setting free for plant use a part of their potash. This is its most important function and it is this property that has made it specially beneficial as a top dressing for clover, a crop that particularly responds to potash. The application of land plaster is usually from 300 to 600 pounds per acre, which may be broadcast on the prepared land and harrowed in.

Large deposits of gypsum occur in New Brunswick, Nova Scotia, and Ontario, and as it is readily quarried and is comparatively soft material, land plaster may be purchased cheaply—in many districts at a lower price than ground limestone.

Users of superphosphate (acid phosphate) will have no necessity to apply land plaster since this phosphatic fertilizer contains sulphate of lime as a necessary constituent.

Nitrate of soda is a well-known, highly efficient nitrogenous fertilizer. It has been shown that crops " feeding upon a neutral salt like nitrate of soda, take up more of the nitric acid than of the soda." This soda acts chemically upon the stores of insoluble potash compounds, setting free a certain amount of potash and thus rendering it unnecessary, in a certain measure, to directly apply a potassic fertilizer. It is this liberation of soda within the soil that is the cause of the deleterious action on the tilth or texture of heavy clay loams when large and frequently repeated applications of nitrate of soda are made, for soda has the property of deflocculating clays, making them sticky when wet and refractory when dry. We should not advise any special application of nitrate of soda to make up for the lack of a potash fertilizer, but it is obvious from what has been stated that its use to a certain degree obviates the necessity of such an application, especially on heavy loams.

THE USE OF POTASH

It is the light, sandy and gravelly soils and muck soils that as a rule are markedly deficient in potash, and on which profitable returns may be expected from the application of this element. The rate of application will, of course, depend on a number of factors, chief among which are the character and fertility of the soil, and the nature of the crops to be grown. For most grain crops an application of muriate of potash of 50 to 75 pounds per acre will probably be found sufficient. For clover and alfalfa these amounts might be doubled with profit. For potatoes, roots, corn and leafy crops generally, 100 pounds of muriate of potash per acre may be considered an average dressing, but frequently 200 pounds may be profitably used. As a rule it will be found more advantageous to use potash with forms of nitrogen and phosphoric acid than alone and it is always advisable to try out the fertilizer on a small scale before making large purchases.

Advice with respect to the use and application of potash and other fertilizers may be obtained by writing the Division of Chemistry, Experimental Farm, Ottawa.

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